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## THE "BIOSPUTNIK" IS CONDUCTING INVESTIGATIONS

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With the launching of the satellite Kosmos-110, Soviet scientists started medical and biological investigation of the regions of intense radiation in the inner radiation belt of the earth. Many readers of this journal are interested in the purpose for which "biosputniks" are placed in orbit and what role they will play in preparing for new manned flights into the Universe. A specialist in the field of space medicine replies to these questions.

A quite large circle of persons who are interested in problems of space navigation believe rather firmly that every new space flight or every new orbit should be performed by space apparatus with animals and other biological objects on board. Is this actually the case? No, it is not. The majority of flights into space will involve man. Flights of space vehicles with animals on board are connected with the need for thorough study of the mechanisms of physiological reactions, investigations of minute changes in the chemical composition or structure of living cells and tissues subjected to factors of prolonged space flight. Investigations involving artificial satellites like the Kosmos-110 are directed precisely toward solving some of these problems and it would be incorrect to regard such satellites merely as means for reconnoitering new paths in space.

In the TASS communication, the satellite Kosmos-110 is called a satellite for biological research. In fact, the principal task of this satellite is to conduct various medical and biological experiments. Space vehicles for such investigations are often called "biosputniks" in the literature. It is obvious that the term "biosputnik" was created in analogy with the term "communications satellite", or "meteorological satellite", that is, satellites designed to solve the problems defined by their names. However, this analogy is only outward; one might say that it is terminological. The fact is that satellites for communications and meteorology are tied to orbits near the earth, which is certainly not obligatory for space vehicles with animals on board which are used for medical and

biological experiments.

Radiation in space is represented by galactic rays (primary cosmic radiation), ionizing radiation of the earth's radiation belts, and radiation produced at the time of chromospheric flares on the sun.

When they penetrate the magnetic field and the atmosphere of the earth, primary cosmic ray particles collide with the atomic nuclei of the gases in the air. In these collisions they undergo varied transformations resulting in loss of energy, ionization of the air, and the formation of the so-called secondary cosmic rays (fragments of atoms and nuclei, electromagnetic radiations). A space vehicle attenuates the effect of protons and offers complete protection against the action of electrons. Protons of the inner radiation belt of the earth represent the principal danger to orbiting space flights.

Nuclear processes on the sun have an enormous effect on the intensity of cosmic radiations. When there are flares on the sun, the intensity of the radiation in interplanetary space and in the radiation belts around the earth may be increased hundreds of times and require special protection for cosmonauts. However, such flares are observed comparatively rarely and the intensity of the radiation increases gradually, which makes it possible to institute the necessary measures.

The radiobiological effect depends on many factors -- the magnitude of the absorbed dose, the type of radiation (density of ionization), the duration of action of the radiation (the dose rate), on whether the organism is wholly or partially irradiated, also on the state of the organism and its resistance.

Experiments conducted with returning space ships and satellites have permitted a sufficiently complete evaluation of the dose of space radiation to be expected at heights of 180 to 320 km. On the basis of these investigations, we can state that space flights below the earth's radiation belts present practically no radiation danger to cosmonauts, of course, if there are no solar flares.

The orbit of the biological satellite Kosmos-110 is considerably higher than the orbits of any manned space ships launched up to this time. It is intended for a prolonged stay in zones of increased radiation in the inner radiation belt of the earth. The presence of animal and various biological objects on board the satellite is of great interest to the study of the biological effects of protons in the earth's radiation belt; this will permit us to test the calculation data, to

obtain data on the relative biological effectiveness, to test the method for calculating shielding, to obtain data on changes in the sensitivity to radiation of various biological objects under the effects of factors in space flight.

Since cosmic radiation may be of enormous significance to the fate of space flight, scientists are studying this factor with great attention. The problem is very large. The problems of prolonged (extending over years) chronic exposure to small doses of ionizing radiation are far from completely studied, there is much to do in regard to investigating the interaction of space radiation and other flight factors (in the first instance, weightlessness).

At present, a large amount of fruitful work is being done to develop pharmaceutical and chemical means for the prophylaxis and therapy of radiation sickness. The specifics of such medicines in space medicine is that these preparations must not reduce the stability of the organism in respect to other flight factors and the working efficiency of human beings. Engineers and physicists are faced with solving important problems of developing such means for physical protection of cosmonauts as materials for the hulls of space vehicles, counter-radiation shielding and shelters, magnetic shielding, et cetera.

The progress achieved in all these investigations is directly connected with the further accumulation of information on the physical characteristics, the properties of space radiation and their biological evaluation under the conditions of actual flight in space. This is the basis for the need for flights of animals and other biological objects along new paths in space.

In ordinary ground laboratory studies of animals there is no need for specially planned and organized service for dogs: feeding, removal of wastes, injecting medicines into their blood, et cetera. This is done by a laboratory assistant or the research physician. During space flight, when all elements of caring for animals are handled without human participation, this is an exceedingly complicated problem which requires a vast amount of attention and work.

In the first flights of satellites with animals on board, a special automatic device was designed for feeding dogs. This was a conveyor belt with special buckets filled with food. The belt was not moved continuously, but periodically, and the current box is stopped and opened in front of the dog's nose.

The so-called sanitary garment was developed to remove

excrement. This was essentially a rubber stocking that permanently connected the animal with the neck of a sanitary tank. Everything seems to be quite simple and reliable. However, these systems had a number of very important shortcomings; for example, one could not be sure that the animal would receive all the food he should get since some quantity of food always remained in the buckets of the automatic feeding device and at times the dog did not eat the food. The sanitary garment greatly hampered the movements of the dog and caused compression and ulcers.

A fundamentally different system was worked out for the Kosmos-110. Here the animals were fed through a stomach tube, that is, through an opening into the stomach, as is done for some patients who have an obstruction of the esophagus.

This operation dogs has been known for a long time, it is widely used and does not present any complications in physiological practice. The food is forced from small sacks under light pressure and a strictly determined amount of nutrients in a paste form enter the stomach directly. A programmed device made it possible to feed dogs on command from the ground.

Solid and liquid wastes were removed by producing a steady current of air through the cabin (a more powerful fan was switched on periodically) which ensured removal of wastes into the sanitary tank under weightlessness conditions.

The system for regeneration of the gaseous medium is the usual one. The system for recording physiological indicators and the possibility of administering pharmacological substances and electrical stimuli constitute the chief element ensuring the solution of problems of flight. When combined with complicated preparation of the animal (the insertion of sounds into the arterial system, the direct measurement of arterial pressure, et cetera), this is a difficult problem even for laboratory experimental work on the ground, because this system ensures the analysis of the physiological mechanisms for regulating the circulation of blood under the conditions of space flight.

The flight of the Kosmos-110 was intended for study of one of the most important problems of space physiology -- the neurohumoral regulation of the cardiovascular system. This is only one of the trends in the investigation of the functional state of a living organism under the conditions of actual space flight.

Weightlessness is such an unusual environmental factor

that before it reveals its secrets, it will be necessary to conduct the most varied and extensive investigations of different physiological systems in space flight, their interaction and functioning in the entire organism.

One may call study of the mechanism of the reaction of the vestibular analyzer under weightlessness conditions an important problem which must be solved in flights of space vehicles with animals on board. In this case, it is necessary to understand the special features of the functioning of the nerve centers in the brain. Studies of minute biochemical processes in cells, the processes of reproduction and division of cells, metabolic processes on the levels of cells and tissues, et cetera belong to the same group of investigations involving the participation of animals.

A great amount of work involving space flights must be done in the field of studying the special features of the reactions of plant organisms to the factors of prolonged space flight. This includes investigations of the processes of photosynthesis, the peculiarities of growth and reproduction of plants, et cetera. The biological problems which must be solved to ensure space flights are most varied. We should like to emphasize that in addition to being applied research, all these investigations are of vital general biological significance. They help us to study the living organism, its peculiarities and possibilities, and to understand the nature of various biological processes.